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[Claim(s)]

[Claim 1]A high intensity polyethylene fiber which tensile strength pulls 15 or more cN/dtex above -2.5-cm^{-1}/% in a Raman shift factor, and is characterized by an elastic modulus being 500 or more cN/dtex.

[Claim 2]The high intensity polyethylene fiber according to claim 1, wherein a stress Raman shift factor is more than -5.5-cm^{-1}/GPa.

[Claim 3]The high intensity polyethylene fiber according to claim 1, wherein a Raman band blow donning factor is below 1.5 cm^{-1}/%.

[Claim 4]The high intensity polyethylene fiber according to claim 1, wherein a stress Raman shift factor is more than -5.5-cm^{-1}/GPa.

[Claim 5]The high intensity polyethylene fiber according to claim 1 characterized by a Raman band shift amount of 1200 seconds after being below 1.5 cm^{-1} in a stress relaxation process after giving fixed distortion.

[Claim 6]The high intensity polyethylene fiber according to claim 1 characterized by change of Raman band blow donning 1200 seconds after being below 2.0 cm^{-1} in a stress relaxation process after giving fixed distortion.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention Highly efficient textiles, such as various sport garments, bulletproof capability, a protective clothing material and a protective glove, and various safety articles, Various rope products, such as a tag rope and a tether line, a yacht rope, and a

structural rope, Curtain material, such as net products and also a chemical filter and battery separators, such as various plaited cord products, such as a fishing line and a blind cable, a fishing net, a safety net, a reinforcer of various nonwoven fabrics or a tent, Or it is related with new high intensity polyethylene fibers industrially applicable to a large area, such as a reinforcing fiber for composites, such as the objects for sports and the objects for speaker cones, such as a helmet and ski, and prepreg.

[0002]

[Description of the Prior Art]Polyethylene of the amount of super-polymers is used as a raw material, it is known by what is called a "gel spinning method" that the high intensity and the rate textiles of high elasticity which are not in the former will be obtained, and it is widely used already industrially so that it may be indicated by JP,S60-47922,B, concerning a high intensity polyethylene fiber. Since the opposite side of these high intensity polyethylene fibers was carried out to the advantage which are high intensity and a rate of high elasticity and it was crystallizing highly, there was a fault which defective structures inevitably eliminated out of a crystal, such as a lattice defect and a molecular terminal, condense in textiles. For this reason, when it was used for the use which requires compressive stress for the contrary of a thing very strong against the direction of a fiber axis pulling, there were problems, like destruction arises in very low compressive stress. Although it was important to make the uniform micro-disperse to whole minimization and fiber structure of number reduction of the defective structure leading to a compressive strength fall and the size of this realize, it was difficult to manufacture the high intensity textiles which have such fiber structure by the conventional method. A polyethylene fiber with the high intensity which can solve such a problem, and the structure which can ease a stress was strongly desired from the industrial world.

[0003]As it is indicated by the JP,64-8732,B gazette, with a weight average molecular weights of 600,000 or more ultra high molecular weight polyethylene is used as a raw material, and the polyethylene fiber of the high intensity and the rate of high elasticity which is not in the former is indicated by what is called a "gel spinning method." However, when manufacturing high intensity and the rate polyethylene fiber of high elasticity using a gel spinning method in this way, since the manufactured textiles are formed from the crystal (high crystal of a degree of order) in which the defect was eliminated highly, condensation of opposite side defective structure still remains into structure. This can be proved by applying a Raman-scattering method so that it may mention later.

[0004]moreover -- even if it sets for a highly efficient product in the polyethylene fiber made from the already marketed melt spinning -- tensile strength -- at most -- it is as 10 cN/dtex and the present condition is that manufacture a high intensity polyethylene fiber which exceeds 15 cN/dtex like this invention, and it is not sold.

[0005]
[Problem to be solved by the invention]It is suppressing the number of the defective structure an effective means existing in textiles corresponding to these extensive demands, and condensation, and carrying out micro-disperse covering the whole fiber structure. By a conventional gel spinning method or melt spinning method, condensation of this defective structure, reduction, and uniform micro-disperse were not able to be attained.
[0006]Inventors presume as follows about this cause. That is, when manufacturing a high intensity polyethylene fiber with melt spinning, since there is very much interlocking of the chain in polymer, after extruding and taking over polymer from a nozzle, it is mentioned that it cannot extend enough. The rate of a portion with a low degree of order as a crystal also with the bad amount of preferred orientation to the direction of a fiber axis will increase, and condensation will produce an internal structure, the textiles manufactured contrary to the above-mentioned gel spinning by that will also form periodic repetition long period structure, and the physical properties of textiles fall as a result. Molecular weight is substantially unable to carry out spinning of the super-high-molecular weight polymer which exceeds 1 million using a melt spinning method on restrictions of fabrication machinery. Even if spinning is made, it cannot extend for sufficiently high magnification, but it becomes what has low hardness.
[0007]In order that molecular weight may lessen a tangle of a chain using polyethylene of the amount of super-polymers exceeding 1 million, there is a technique of the above-mentioned gel spinning. In this case, crystallization and ordering will make into an altitude structure of the textiles obtained as a result although it became possible to perform super-drawing operation so that long period structure is not observed in corniculus X-rays line dispersion measurement, but. In order that condensation of the defective structure which is never eliminable might generate so that it may explain in detail as reaction later, when this condensation gave distortion to textiles, there was a problem by which the cause of the big stress distribution is carried out to the inside of textiles. Such a defect is considered to be one of the factors which check improvement in compression characteristics at least.
[0008]Condensation of defective structure and the relation of the internal stress distribution attracted by external distortion are described. Termonia and others inquired about the relation of the stress distribution and structure which are generated inside the substance which carried out the orientation in the direction of a fiber axis highly using the lattice model (Macromolecules18 and 2246 (1985)). According to their research findings, when distortion is given to textiles, the portion causes stress concentration, and the amorphous part left during the molecular terminal or the crystal brings about reduction of textiles hardness or an elastic modulus in physical properties. Stress distribution is simultaneously induced the inside of textiles. The stress distribution produced in structure can be measured using a Raman-

scattering method, as Young and others showed (Journal of Materials Science, 29, 510 (1994)). . [a Raman band, i.e., a normal vibration position,] [by solving the equation which comprises the force constant of a chain and the form (internal coordinates) of a molecule which constitute textiles] Although determined (E. B. Wilson, J. C. Decius, P.C. Cross work Molecular Vibrations, and Dover Publications (1980)), This molecule is also distorted and a normal vibration position changes as a result as Wool and others gave explanation as theoretical explanation of this phenomenon and textiles are distorted (Macromolecules, 16, and 1907 (1983)). When structure heterogeneity, such as defective condensation, exists, and external distortion is given, the stresses by which a cause is carried out in the part in textiles will differ. It will be said that it can do a fixed quantity of stress distribution induced the inside of textiles since that hardness and relation of change of a Raman band profile were investigated when distortion is conversely applied to textiles, since this change is detectable as change of a band profile. That is, the textiles with small structure heterogeneity come to take the value of a field with a Raman shift factor, a blow donning factor, a Raman band shift amount, etc. so that it may mention later.

[0009]This invention excels [obtain / by a technique like such conventional melt spinning or gel spinning] in difficult compression characteristics, And tensile strength succeeds in 15 or more cN/dtex and obtaining the high intensity polyethylene fiber which it pulls, and an elastic modulus is 500 or more cN/dtex, and has the feature on the fiber structure that the stress distribution by which a cause is carried out to an inside when distortion is given to textiles at a surprising thing is small.

[0010]

[Means for solving problem]That is, this invention consists of the following composition.

1. High intensity polyethylene fiber which tensile strength pulls 15 or more cN/dtex above -2.5-cm^{-1}/% in Raman shift factor, and is characterized by elastic modulus being 500 or more cN/dtex.

2. High intensity polyethylene fiber given in one, wherein stress Raman shift factor is more than -5.5-cm^{-1}/GPa.

3. High intensity polyethylene fiber given in one, wherein Raman band blow donning factor is below 1.5 cm^{-1}/%.

4. High intensity polyethylene fiber given in one, wherein stress Raman shift factor is more than -5.5-cm^{-1}/GPa.

5. High intensity polyethylene fiber given in one characterized by the Raman band shift amount of 1200 seconds after being below 1.5 cm^{-1} in the stress relaxation process after giving fixed distortion.

6. High intensity polyethylene fiber given in one characterized by change of Raman band blow

donning 1200 seconds after being below 2.0 cm^{-1} in the stress relaxation process after giving fixed distortion.

[0011]In order to obtain the textiles concerning this invention, it traced wholeheartedly that defective structure is reduced even to the infinitesimal, or it was necessary to close and to make the whole textiles distribute defective size uniformly if minute even in size comparable as a molecular terminal as a result of examination. The method of manufacturing the textiles of such a state is not limited to it, although the following methods are recommended, for example. The weight average molecular weights of polyolefine of the greatest feature of this invention are 60,000-600,000, It is that the ratio (Mw/Mn) of a weight average molecular weight to a number average molecular weight carries out melting extrusion of the polymer which is 4.5 or less, cools the extruded melt, and performs further extension at the temperature below the crystalline dispersion temperature of these textiles.

[0012]That is, it is important that the weight average molecular weights of raw material olefin polymer are 60,000-600,000 in manufacture of the textiles concerning this invention, and it is important that the ratio (Mw/Mn) of a weight average molecular weight to a number average molecular weight becomes 4.5 or less. It is important preferably that the weight average molecular weights of raw material olefin polymer are 60,000-300,000, and it is important that the ratio (Mw/Mn) of a weight average molecular weight to a number average molecular weight becomes 4.0 or less. It is important that the weight average molecular weights of raw material olefin polymer are 60,000-200,000 still more preferably, and it is very important that the ratio (Mw/Mn) of a weight average molecular weight to a number average molecular weight becomes 3.0 or less.

[0013]Olefin polymer in this invention is characterized by the repeating unit being ethylene substantially, and alpha olefin copolymerizes as a little other monomers. When manufacturing these textiles, making branching of a long chain contain to some extent by using alpha olefins and a copolymer will give the stability on the silk manufacture especially in spinning, and it is more preferred. That is, it becomes possible by making polyethylene contain long-chain branching to reduce the development of the melt fracture at the time of spinning so that it may be indicated by JP,2963199,B. However, if content other than ethylene increases too much, since it will become an inhibition factor of extension on the contrary. [from a viewpoint of obtaining high intensity and the rate textiles of high elasticity] it is preferred that the branched chain of the length which has five or more carbon is 0 per 1,000 carbon and 01-3 pieces or less -- it is 0.01-1 per 1,000 carbon more preferably, and is 0.05-1.0 piece still more preferably. Polymerizing using a metallocene catalyst is possible so that such polyethylene polymer may be indicated by JP,2963199,B, but thereby, it is not limited.

[0014]Since the molecular weight of what is easy to carry out melt molding processing is low when the weight average molecular weight of raw material polyethylene becomes less than

60,000, the hardness of the yarn actually obtained will become small. With high-molecular weight polyethylene in which the weight average molecular weight of raw material polyethylene exceeds 600,000, melt viscosity becomes very high and a melting molding process becomes very difficult. If the ratio of the weight average molecular weight and number average molecular weight of fibrous voice becomes 4.5 or more, the hardness of the yarn with which the highest draw magnification was low obtained again as compared with the case where polymer of the same weight average molecular weight is used will become low. Since a low molecular weight constituent increases when a molecular weight distribution becomes large, that a fracture arises without the ability to finish extending when a chain with long relaxation time extends, and, this is surmising that strength reduction happens, when a molecular terminal increases.

[0015]In this invention, the technique of obtaining a high intensity polyethylene fiber was devised from the above raw material polyethylene by inquiring wholeheartedly. That is, melting of such raw material polyethylene is carried out with an extruder, and it is made to breathe out via a spinneret quantitatively with a gear pump. This filiform one is cooled in a cold blast after that, and it takes over at the rate of predetermined. It is important to extend enough and to take over at this time. that is, it is important that there is a ratio of spinning velocity and discharge linear velocity or more by 100 -- it is 200 or more still more preferably 150 or more preferably. It can roll round with discharge linear velocity and the ratio of velocity can be calculated from a spinneret caliber, a foramen-singulare discharge, an olefin polymer density, and rolling-up velocity.

[0016]It is most important to extend by the method that these textiles are shown below succeedingly. That is, it is important to perform further extension at the temperature below the crystalline dispersion temperature of these textiles, and to extend these textiles further at the temperature beyond the crystalline dispersion temperature of these textiles. It found out that the physical properties of textiles improved, so that he was surprised by adopting the above techniques. At this time, textiles may be further extended in many stages. Again. Even if a stretching process performs a stretching process as it is, without performing a stretching process off-line and once rolling round the undrawn yarn rolled round once from a spinning process, it is easy to be natural [a stretching process]. An extension method in particular is not scrupulous. Although a publicly known technique, for example, roller extension, slit extension, etc. are recommended until now, it is not limited to this.

[0017]The absorption of the normal polyethylene orientation thing observed most at the high temperature side is called crystalline dispersion, and it is thought that it is participating in the chain thermal motion in a crystal phase directly. This crystalline dispersion temperature can be measured by performing dynamic viscoelasticity measurement. That is, the absorption which calculates a loss tangent, takes these three values acquired at each temperature along

a vertical axis by logarithm, plots a horizontal axis at temperature, and appears in the high temperature side most from the storage modulus and loss modulus which were obtained by measurement is crystalline dispersion.

[0018]So that it may be indicated by document of a large number, such as USP4228118, JP,H8-504891,A, and JP,H5-186908,A, When extending polyolefine textiles, it is indicated that it is preferred to heat these textiles and to extend above at least 50 ** also in respect of physical properties and productivity. However, in this invention, when it disagreed with old art and these textiles were extended to the surprising thing by the temperature conditions below the crystalline dispersion temperature of these textiles, it found out that textiles physical properties improved by leaps and bounds to it, and it was reached at this invention.

[0019]That is, it is very important to perform further extension in a desirable temperature range lower not less than 40 ** less than 70 ** than the crystalline dispersion temperature of these textiles and a still more desirable not less than 50 ** temperature range low less than 60 Centigrade. It is important after the 2nd step of extension to extend at a temperature high not less than 20 ** more desirable than the crystalline dispersion temperature of these textiles and a still more desirable temperature high not less than 30 **.

[0020]Although the Reason whose textiles physical properties improve by performing further extension at the temperature below the crystalline dispersion temperature of these textiles is not certain, it is guessing as follows. That is, orientation tension is applied by textiles by extending at the temperature below the crystalline dispersion temperature of these textiles. Although extended below at the crystalline dispersion temperature of these textiles, it is hard to move the crystal itself to a sake by extension, and extension of only an amorphism portion is mainly carried out to it. That is, soiling by rubbing **** of the chain from a crystal hardly happens like a super-drawing. Although the structure where extension after the 2nd step is performed smoothly is formed in textiles of this, extension after the 2nd step is performed smoothly and that whose physical properties of the textiles after extension improve is conjectured, it is not certain for details.

[0021]The measuring method and measurement condition about the characteristic value in this invention are explained below.

[0022](Hardness and elastic modulus), [the hardness in this invention, and an elastic modulus] Using the "tensilon" by a cage ene tick company, 200 mm (length between zippers) of sample length, It calculated and asked for the elastic modulus (cN/dtex) from the 100% of rate-of-extension tangent which measures distortion-stress lines on condition of for /under the ambient temperature of 20 **, and 65% of relative humidity conditions, and gives the maximum inclination hardness (cN/dtex) and near the curved starting point for the stress in a fracture point. Each value used the average of 10 times of measured value.

[0023](The weight average molecular weight Mw, number average molecular weight Mn, and

Mw/Mn) The weight average molecular weight Mw, number average molecular weight Mn, and Mw/Mn were measured by the gel permeation chromatography (GPC). As a GPC device, it had product GPC made from Waters 150 C ALC/GPC, and GPC UT802.5 made from SHODEX was measured, using 1UT806M two as a column. The measurement solvent carried out 145 ** of column temperature using o-dichlorobenzene. Sample concentration was carried out in ml and 1.0mg /, carried out 200-micro liter pouring, and measured. The calibration curve of molecular weight is constituted using the polystyrene sample of molecular weight known by the universal calibration method.

[0024](Measurement of branching) It opts for measurement of branching of olefin polymer using 13 C-NMR (125 MHz). It measured using how for the method (Rev.Macromol.Chem.Phys., C29 (2&3), P.285-297) of Randal (Randall) to be indicated.

[0025](Dynamic viscosity elastic measurement) Dynamic viscosity measurement in this invention was performed using the "REOBAIBURON DDV-01FP type" by a cage ene tech company. textiles will be 100 deniers **10 deniers as a whole -- as -- yarn dividing -- or it doubles, it considers so that each single fiber may arrange as uniformly as possible, and the both ends of textiles are wrapped in aluminum foil, and it pastes up with cellulosic adhesive so that measurement length (distance between scissors metal fittings) may be set to 20 mm. carry out a paste in that case -- length shall be about 5 mm in consideration of immobilization with scissors metal fittings. As for each specimen, yarn slackened to the scissors metal fittings (zipper) set as an initial width of 20 mm, or it was twisted, or bent and was carefully installed like, and this experiment was conducted after giving reserve modification several seconds on the temperature of 60 **, and the frequency of 110 Hz beforehand. In this experiment, it asked for the temperature dispersion in the frequency of 110 Hz from the low temperature side at about 1 ** the heating rate for /in a -150 to 150 ** range. In measurement, static load was set as 5gf, and sample length was made to adjust automatically so that textiles may not slacken. An amplitude of dynamic modification was set as 15 micrometers.

[0026](Ratio of discharge linear velocity to spinning velocity (draft ratio))
Draft ratio (psi) = spinning velocity (Vs) / discharge linear velocity (V) to which draft ratio (psi) is given by the following formulas

[0027](Raman-scattering measurement) The Raman scattered spectrum measured by the following method. The Raman measuring apparatus (spectroscope) was measured using Reni Shaw's system 1000. Using He Ne laser (wavelength of 633 nm), the light source installed and measured textiles so that a fiber axis might become parallel in the polarization direction. Yarn dividing of the single fiber (monofilament) was carried out from yarn, on the center line of the hole of the board as for which the rectangular (50 mm by 10 mm) hole was vacant, it stuck so that a macro axis might be in agreement with a fiber axis, and both ends were stopped with epoxy adhesive (Araldite), and were neglected for more than two days. These textiles were

attached to the jig which can adjust length by a micrometer after that, after cutting off the board holding single fiber carefully, a predetermined distortion was given to textiles, and it put on the microscope stage of this Raman-scattering device, and the Raman spectrum was measured. At this time, the stress committed for textiles was simultaneously measured using the load cell. Measurement of Raman made the resolution per pixel below 1 cm^{-1} in Static Mode about 1350 $cm^{-1}$from 850 cm of test range $^{-1}$, and collected data. The peak used for analysis adopted the band of 1128 cm^{-1} which belongs to the meristic elastic mode of a C-C skeletal bond. In order to ask for a band centroid position and line width (the standard deviation of the profile centering on the band center of gravity, square root of a secondary moment) correctly, it turned out that a curve fit can be well carried out by approximating this profile as synthesis of two Gaussian functions. When distortion was applied, it became clear that the peak position of two Gaussian functions was not in agreement, and those distance kept away. When such, in this invention, a band position was not considered to be the peak of a peak profile, but it was defined with it being also in the centroid position of two gauss peaks as the band peak position. A definition is shown in the formula 1 (a centroid position, <x>). The square root (standard deviation) of the secondary moment when it is considered as the center of this band defined the centroid position explained by the formula 2 also about blow donning (spreading of Broadening= line width) of a peak. The definition was shown in the formula 2 (standard deviation, SD). Initial inclination (change of a centroid position when changing distortion 1%) when the graph which plotted band centroid position <x> and given distortion was created was defined as the Raman shift factor (SF). The example of evaluation is shown in drawing 1. Initial inclination (change of SD when changing distortion 1%) when the graph plotted to distortion which gave the standard deviation which the top defined similarly was created was defined as the Raman band blow donning factor (BF). The example of evaluation is shown in drawing 2. Initial inclination (change of the centroid position per increase in stress 1GPa) when the band centroid position was plotted to the stress committed for textiles when distortion is given defined the stress Raman shift factor (RF). About measurement of the relaxation process, the spectrum of 30 seconds after [from] and the spectrum of 1230 seconds after were evaluated immediately after applying 3.5% of distortion to textiles, a centroid position and standard deviation were evaluated, respectively, and it asked for change (SC) of a Raman band shift amount (SA) and blow donning.

[0028]<x> =integralxf(x)dx/integralf(x)dxf(x)=f_1(x-a)+f_2 (x-b)

f_i expresses a Gaussian function here.

[0029]SD=[integral(x-<x>) ^{2}f(x)dx/integralf(x)dx] $^{0.5}$ -- f is synthesis of a Gaussian function which the formula 1 defined here.

[0030]
[Working example]Hereafter, this invention is explained with an embodiment.
[0031](Embodiment 1) Branched chain of length with which a ratio of the weight average molecular weight 115,000 and a weight average molecular weight to a number average molecular weight has 2.3 or 5 or more carbon high density polyethylene which is 0.4 per 1,000 carbon phi0.8mm, It extruded at the rate of foramen-singulare discharge 0.5 g/min at 290 ** from a spinneret which consists of 30H. It is cooled by quenching of 20 ** and 0.5 m/s after that through the 15-cm incubation section, and extruded textiles are rolled round at the rate of 300 m/min. This undrawn yarn was extended by possible Nelson Rolle of two or more sets of thermal control. One-step extension performed 2.8 times as many extensions at 25 **. It heated to 115 more **, 5.0 times as many extensions were performed, and a full oriented yarn was obtained. The physical properties of obtained textiles were shown in Table 1.
[0032](Embodiment 2) The full oriented yarn of Embodiment 1 was heated at 125 **, and further 1.3 times as many extensions were performed. The physical properties of the obtained textiles were shown in Table 1.
[0033](Embodiment 3) The full oriented yarn was created on the same conditions as Embodiment 1 except the 1st step of draft temperature having been 40 **. The physical properties of the obtained textiles were shown in Table 1.
[0034](Embodiment 4) The full oriented yarn was created on the same conditions as Embodiment 1 except the 1st step of draft temperature having been 10 **. The physical properties of the obtained textiles were shown in Table 1.
[0035](Embodiment 5), [the branched chain of length with which the ratio of the weight average molecular weight 152,000 and a weight average molecular weight to a number average molecular weight has 2.4 or 5 or more carbon] [high density polyethylene which is 0.4 per 1,000 carbon] The full oriented yarn was obtained from the spinneret of phi0.9mm and 30H like Embodiment 1 except having extruded at the rate of foramen-singulare discharge 0.3 g/min at 300 **. The physical properties of the obtained textiles were shown in Table 1.
[0036](Comparative example 1) The full oriented yarn was created on the same conditions as Embodiment 1 except the 1st step of draft temperature having been 90 **. The physical properties of the obtained textiles were shown in Table 2.
[0037](Comparative example 2) The full oriented yarn was created on the same conditions as Embodiment 1 except the 1st step of draft temperature having been 90 **, and having made draw magnification into 3.0 times per step, and the 2nd step of 7.0 times. The physical properties of the obtained textiles were shown in Table 2.
[0038](Comparative example 3) Although the full oriented yarn was created on the same conditions as Embodiment 1 except the branched chain of length with which the ratio of the

weight average molecular weight 123,000 and a weight average molecular weight to a number average molecular weight has 2.5 or 5 or more carbon having used high density polyethylene which is 12 per 1,000 carbon, Yarn pieces occurred frequently at the time of extension, and only the full oriented yarn of low draw magnification was obtained. The physical properties of the obtained textiles were shown in Table 2.

[0039](Comparative example 4) The branched chain of length with which the ratio of the weight average molecular weight 121,500 and a weight average molecular weight to a number average molecular weight has 5.1 or 5 or more carbon high density polyethylene which is 0.4 per 1,000 carbon phi0.8mm, The undrawn yarn was created like Embodiment 1 except having extruded at the rate of foramen-singulare discharge 0.5 g/min at 270 ** from the spinneret which consists of 30H. 2.8 times as many extensions were performed for this undrawn yarn at 90 **. Furthermore, it heated to 115 ** after that, 3.8 times as many extensions were performed, and the full oriented yarn was obtained. The physical properties of the obtained textiles were shown in Table 2.

[0040](Comparative example 5) 2.8 times as many extensions were performed for the undrawn yarn obtained by the comparative example 4 at 40 **. Furthermore, it heated to 115 ** after that, 4.0 times as many extensions were performed, and the full oriented yarn was obtained. The physical properties of the obtained textiles were shown in Table 2.

[0041](Comparative example 6) The undrawn yarn was created like the comparative example 4 except having made spinning velocity into 80 m/min. 2.8 times as many extensions were performed for this undrawn yarn at 80 **. Furthermore, it heated to 115 ** after that, 4.0 times as many extensions were performed, and the full oriented yarn was obtained. The physical properties of the obtained textiles were shown in Table 2.

[0042](Comparative example 7) The branched chain of length with which the ratio of the weight average molecular weight 123,000 and a weight average molecular weight to a number average molecular weight has 6.0 or 5 or more carbon high density polyethylene which is zero per 1,000 carbon phi0.8mm, At 295 **, the undrawn yarn was created like Embodiment 1 from the spinneret which consists of 30H except having extruded at the rate of foramen-singulare discharge 0.5 g/min. 2.8 times as many extensions were performed for this undrawn yarn at 90 **. Furthermore, it heated to 115 ** after that, 3.7 times as many extensions were performed, and the full oriented yarn was obtained. The physical properties of the obtained textiles were shown in Table 2.

[0043](Comparative example 8) The branched chain of length with which the ratio of the weight average molecular weight 52,000 and a weight average molecular weight to a number average molecular weight has 2.3 or 5 or more carbon high density polyethylene which is 0.6 per 1,000 carbon phi0.8mm, At 255 **, the undrawn yarn was created like Embodiment 1 from the spinneret which consists of 30H except having extruded at the rate of foramen-singulare

discharge 0.5 g/min. 2.8 times as many extensions were performed for this undrawn yarn at 40 **. Furthermore, it heated to 100 ** after that, 5.0 times as many extensions were performed, and the full oriented yarn was obtained. The physical properties of the obtained textiles were shown in Table 2.

[0044](Comparative example 9) Although it tried to perform spinning using high density polyethylene whose branching of length to which a ratio of the weight average molecular weight 820,000 and a weight average molecular weight to a number average molecular weight has 2.5 or 5 or more carbon is 1.3 per 1,000 carbon, Melt viscosity was not able to pass highly and it was not able to extrude uniformly.

[0045](Comparative example 10) An example of measurement of Dyneema SK60 is shown in Table 3.

[0046](Comparative example 11) An example of measurement of the spectra 1000 is shown in Table 3.

[0047]

[Table 1]

		実施例1	実施例2	実施例3	実施例4	実施例5
重量平均分子量(ポリマー)	g/mol	115,000	115,000	115,000	115,000	152,000
Mw/Mn(ポリマー)	-	2.3	2.3	2.3	2.3	2.4
５個以上の炭素を有する長さの分岐鎖	個/炭素1,000個	0.4	0.4	0.4	0.4	0.8
単孔吐出量	g/min	0.5	0.5	0.5	0.5	0.3
紡糸速度	m/min	300	300	300	300	200
ドラフト比	-	225	225	225	225	316
結晶分散温度	℃	63	63	63	63	67
１段延伸温度	℃	5	10	15	10	20
１段延伸倍率	-	2.8	2.8	2.8	2.8	2.4
２段延伸温度	℃	115	115	115	115	115
２段延伸温倍率	-	5.0	5.0	5.0	5.0	4.8
３段延伸温度	℃		125			
３段延伸倍率	-		1.2			
総延伸倍率	-	14.0	16.8	14.0	14.0	11.5
繊度	Dtex	36	30	36	36	65
強度	cN/dtex	18.2	19.1	17.9	18.7	18.9
弾性率	cN/dtex	820	880	801	871	820
SF	cm^{-1}/%	-1.21	-0.55	-1.41	-0.89	-0.99
BF	cm^{-1}/%	1.39	0.37	1.43	0.57	1.04
SA	cm^{-1}	1.43	0.78	1.35	1.01	0.99
SC	cm^{-1}	1.81	0.44	1.72	0.78	1.34
RF	cm^{-1}/GPa	-4.3	-4.1	-4.6	-4.1	-4.2

[0048]

[Table 2]

		比較例1	比較例2	比較例3	比較例4	比較例5	比較例6	比較例7	比較例8	比較例9
重量平均分子量(ポリマー)	g/mol	115,000	115,000	123,000	121,500	121,500	121,500	123,000	52,000	820,000
Mw/Mn(ポリマー)	-	2.3	2.3	2.5	5.1	5.1	5.1	6.1	2.3	2.5
５個以上の炭素を有する長さの分岐鎖	個/炭素1,000個	0.4	0.4	12	0.4	0.4	0.4	0	0.6	1.3
単孔吐出量	g/min	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
紡糸速度	m/min	300	60	300	300	300	80	300	300	
ドラフト比	-	225	45	225	225	225	60	225	225	
結晶分散温度	℃	63	56	57	64	64	57	64	54	
１段延伸温度	℃	45	90	10	90	40	80	90	40	
１段延伸倍率	-	2.8	3.0	2.0	2.8	2.8	2.8	2.8	2.8	
２段延伸温度	℃	115	115	115	115	115	115	115	100	
２段延伸温倍率	-	5.0	7.0	4.1	3.8	4.0	4.0	3.7	5.0	
総延伸倍率	-	14.0	21.0	8.2	10.6	11.2	11.2	10.4	14.0	
繊度(dtex)	Dtex	36	119	61	47	45	167	48	36	
強度(cN/dtex)	cN/dtex	16.1	12.1	14.2	13.1	13.4	10.1	12.8	9.4	
弾性率(cN/dtex)	cN/dtex	620	320	471	433	440	280	401	301	
SF	cm⁻¹/%	-2.12	-2.31	-3.01	-2.91	-2.99	-2.24	-2.30	-2.98	
BF	cm⁻¹/%	1.71	1.58	1.64	1.65	1.76	1.80	1.94	1.98	
SA	cm⁻¹	1.59	1.78	1.61	1.89	1.63	1.89	1.76	1.70	
SC	cm⁻¹	2.31	2.68	2.33	2.57	2.22	2.21	2.89	2.60	
RF	cm⁻¹/GPa	-5.9	-8.1	-6.9	-7.3	-7.0	-9.1	-7.1	-8.6	

[0049]

[Table 3]

	-	比較例１０	比較例１１
繊度(dtex)	Dtex	557	562
強度(cN/dtex)	cN/dtex	26.7	25.1
弾性率(cN/dtex)	cN/dtex	814	809
SF	cm⁻¹/%	-3.81	-3.75
BF	cm⁻¹/%	2.61	2.77
SA	cm⁻¹	3.67	3.59
SC	cm⁻¹	2.78	2.89
RF	cm⁻¹/GPa	-4.4	-4.3

[0050]

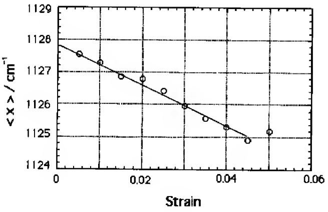
[Effect of the Invention]According to this invention, offer of the high intensity polyethylene fiber which has improved the dynamics physical properties which have a new and homogeneous structure was attained.

[Brief Description of the Drawings]

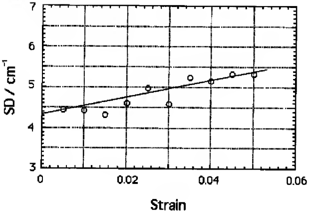
[Drawing 1]The graph which shows the relation between band centroid position <x> and given distortion.

[Drawing 2]The graph which shows the relation between the standard deviation of band centroid position <x>, and given distortion.

[Drawing 1]



[Drawing 2]



[Translation done.]